be detected by the other observers because of their low frequencies of alternation. The result was that the curves of these observers gave them apparent abnormal increases in the mobility of the negative ion, which increased in value with decreasing pressures. In my experiments these electrons were of course absent, and so no apparent abnormal increase was obtained.

The conclusion to be drawn from these results seems to be that the 'cluster' theory, which has until now been most generally accepted, is not correct. This forces us to accept the 'small ion' theory in some form or other.

Summary.—1. The mobilities of positive ions have been determined in electric fields very nearly strong enough to cause ionisation by collision at atmospheric pressures and have been found to be perfectly normal within the limits of error of the measurement.

2. The mobilities of the negative ions have also been determined, under the same circumstances, with the result that they not only showed no relative abnormal increase in value over those of the positive ion, but also showed a perfectly normal absolute value of the mobility.

3. These results, though at variance with those of most observers at low pressures for the negative ions, are in good agreement with recent results of Wellisch,[5] and likewise lead to the conclusion that the 'cluster' theory is no longer tenable.

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THE RELATION OF MYELIN TO THE LOSS OF WATER IN THE MAMMALIAN NERVOUS SYSTEM WITH ADVANCING AGE

By Henry H. Donaldson

WISTER INSTITUTE OF ANATOMY AND BIOLOGY, PHILADELPHIA

Read before the Academy, April 17, 1916. Received, June 6, 1916

Starting from birth, the water-content of the mammalian body diminishes with age, and the same statement holds for the several anatomical systems which compose the body (Lowrey[1]). My own studies have been made on the albino rat in which the changes in the water-

content of the central nervous system have been followed as a phenomenon of growth (Donaldson[2, 3, 4, 5]).

The progressive loss in the percentage of water in the brain and in the spinal cord is closely linked with age, although it can be slightly modified by nutritive conditions. The age of the animal becomes therefore the most important datum when a determination of the percentage of water is to be made.

In Chart 1 the change, on age, of the percentage of water in the brain and in the spinal cord of the male albino rat is shown by graphs. The observed mean values for groups of cases are indicated by small dots, for the brain, and by small triangles, for the cord. The respective graphs were determined by formulas devised by Dr. S. Hatai, and based on the observed group values (Donaldson[6]). Along the graph for the brain are seen four large dots. These represent observations on the human brain—taken from Koch and Mann, and from Weisbach.[7, 8]

Table 1 gives the percentage of water and the age of the human brains here used and also the equivalent rat ages.

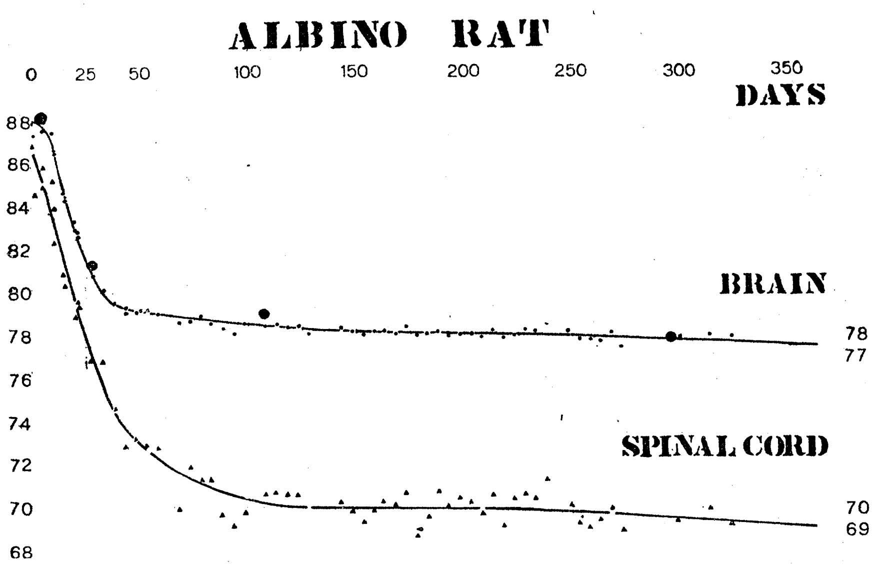

CHART 1

Showing the percentage of water, on age, in the central nervous system of the albino rat. The upper graph gives the values for the water in the brain as determined by the formulas (Hatai—in 'The Rat,' Donaldson,[9]—1915). The lower graph gives the corresponding values for the spinal cord, determined in the same way.

The small black dots indicate the observed values for the several age groups for the brain—and form the data for the formulas. The small black triangles have a like value in relation to the spinal cord.

The large black dots along the graph for the brain represent the human data as given in Table 1.

TABLE 1

Percentages of water in the human brain

Koch and Mann, (K); Weisbach, (W)

HUMAN AGE, YEARS	OBSERVER	PERCENTAGE OF WATER	EQUIVALENT RAT AGE DAYS
Birth	(W)	88.3	Birth
2.0	(K)	81.1	26
9.5	(W)	79.2	115
25.0	(W) (K)	(77.0) (77.8)	290

We find that the span of life for man is about thirty times as long as that for the rat and hence by reducing any observed human age to one-thirtieth of its value we obtain the corresponding rat-age to which it is equivalent. These equivalent ages are given in Table 1. As is seen from the chart, when the water determinations for man are entered in accordance with this age relation they agree well with those for the rat. We conclude, therefore, that essentially the same process is occurring in the brains of both man and the rat—only in the rat it is proceeding thirty times faster than in man. These relations have been pointed out here in order to show that the conclusions reached at the end of this paper will probably apply to man, although directly based on the rat.

The fact that there is a progressive loss of water in the brain and in the spinal cord with advancing age having been established, it is desirable to consider the organs themselves and to find how this loss is distributed within them. The following analysis applies both to the brain and to the spinal cord—but, for convenience, it will be given as if for the brain alone. The brain is very largely composed of nerve cells or neurons. When reduced to its simplest terms a neuron consists of a cell body—with a principal outgrowth—the axon. All axons are free from visible myelin sheaths when young—but as they mature many, but not all, acquire rather thick sheaths of myelin. Myelin is a morphological term used to designate these sheaths, which are composed mainly of lipoids and which give the nerve fibers a white color. Broadly speaking, there is little or no visible myelin present in the brain at birth—while with advancing age it increases rapidly, and at maturity forms a considerable portion of the entire brain.

It is my purpose to determine by this study whether the loss of water, which occurs in the brain between birth and maturity, takes place equally in the cell body and its axon, on the one hand, and in the myelin sheaths, on the other, or whether this loss is unequally distributed.

By way of introduction the following data from the literature are presented (de Regibus[10]).

In man at birth the brain has about 88% of water and both the gray substance (in which cell bodies are abundant), and masses of fibers alone (later to become 'white substance'), have the same percentage. At maturity, however, the case is very different, as will be seen from Table 2.

TABLE 2

Percentage of water. Human brain

	CORTEX (GRAY)	CALLOSUM (WHITE)
	per cent	*per cent*
At Birth	88.0	88.0
At Maturity	86.0	70.4

According to this table the (gray) cortex has lost 2 points and the (white) callosum, 17.6 points in the process of maturing.

It is never possible to obtain at maturity the cortex, or any other gray mass, without an admixture of some myelinated fibers, and I have therefore credited one point of the loss, noted in the water content of the cortex, to the presence of such fibers.

According to this assumption the mature gray substance, when the myelin of the myelinated fibers is excluded, contains 87% of water.

In the computations which follow, the neurons (= cell bodies and axons), without myelin, are assumed to have 87% of water.

The fact that the fibers without myelin (see Table 2) have at birth a high percentage of water (88%) while at maturity, after myelination, they have lost 17.6 points, indicates that either axons of this type have a peculiar capacity for losing water, or that the accumulation of myelin has caused the reduction observed.

To obtain a notion of the approximate distribution of the water between the myelin and neurons proper, it is necessary to have data on the relative abundance of these two constituents of the brain.

In 1913 W. Koch and M. L. Koch[11] made a study of the chemical composition of the brain of the albino rat at six ages, between birth and maturity, and of the spinal cord, at one age. The data thus obtained are those which will be utilized here. The authors determined seven fractions:—proteins, organic extractives and inorganic constituents, which three taken together, we shall designate, protein (or non-lipoid); and phosphatides, cerebrosides, sulphatides and cholesterol, which four taken together, we shall designate, lipoid.

These data give us at each age, therefore, the protein and the lipoid

present in the brain, or to be a little more exact, we should say the lipoid and the non-lipoid fractions. The lipoid (in part) represents the myelin sheaths, while the protein, with part of the lipoid, represents the cell bodies and their unsheathed axons.

With the exception of the one day group, the ages for which analyses were made are given in Table 3.

At one day—or practically birth—it is found that the lipoid is present to the extent of 0.31 or nearly one-third of the weight of the protein. There is, however, no visible myelin at this age, so it is concluded that this proportion of the total lipoid is normally associated with the protein and is not to be included in the lipoid which forms the myelin sheaths. We have treated the data for the later age groups in accordance with this relation—and in each case have taken from the total lipoid found an amount equal to 0.31 of the protein found. The remaining amount of lipoid is assumed to be that used for the sheaths.

In Table 3, the column (2) headed 'Corrected Protein' gives the observed protein (non-lipoid) plus 0.31 of itself—and the column (3) headed 'Corrected Lipoid' gives the observed lipoid less the amount of lipoid added to the protein.

TABLE 3

To show for five brains of the Albino rat and for one spinal cord the percentage of water in the myelin as computed according to the method described. The protein and lipoid are given in percentages of the total dry substance (Based on Table 2. Koch and Koch)[11]

(1)	(2)	(3)	(4)	(5)	(6)	(7)
				PERCENTAGE OF WATER		
AGE IN DAYS	CORRECTED PROTEIN. PER CENT	CORRECTED LIPOID. PER CENT	PROPORTION OF LIPOID FOR DIFFERENT AGES. LIPOID AT 20 DAYS = 1	Entire brain observed.	In neurons = Protein (C) (assumed).	In myelin = lipoids (C) (computed).
			Brain			
10	93.80	6.2		86.5	88	63.8*
20	88.88	11.12	1.	82.5	87	46.5†
40	82.86	17.14	1.5	79.4	87	42.7
120	75.11	24.84	2.2	78.4	87	52.4
210	76.36	23.63	2.1	78.1	87	47.4
Average of 20 to 210 days						47.8
			Spinal Cord			
120	52.92	47.08	4.2	70.4	87	51.0

* First traces of myelin. † Myelin well shown.

In Table 3 the data are given in five age groups for the brain and in one age group for the spinal cord. It is to be noted that the 10 day brain group—which stands just at the beginning of the myelin formation—is here excluded from the discussion and we begin the comparisons which are to be made, with the 20 day brain group.

In the brain series (with one exception) the corrected protein diminishes and the corrected lipoid increases with advancing age. Between 20 and 210 days the proportion of the lipoid doubles. We have, in column (5), the observed percentage of water in the brain as a whole. It is assumed, as previously noted, that the corrected protein (neurons, in the strict sense: = both cell-bodies and axons) have 87% of water. From these several data we can compute the percentage of water to be assigned to the corrected lipoid, which represents the myelin.

The method of computation may be illustrated by the data for the 20 day group. Reference to Table 3 shows that, at this age, there is 1 part of lipoid (11.12%) to 8 parts of protein (88.88%). This gives 9 parts, representing the entire brain and having 82.5% of water. The product, $9 \times 82.5 = 742.5$. We assume that the 8 parts of protein have 87% of water. The product, $8 \times 87 = 696$. The 1 part of lipoid, representing the myelin, will then have a percentage of water equal to the difference of these products: $742.5 - 696 = 46.5\%$.

The values thus obtained are entered in column (7), and, taken together, the four entries give a mean value of 47.8% of water for the myelin.

In this connection it should be noted that the spinal cord, which has about twice as much lipoid as the brain at the same age, gives also a similarly low value for the water in the myelin—51%.

The significance of these results lies not in the particular percentage of water here determined for the myelin—as that depends on the percentage of water assumed for the protein—but in the similarity of the values found in all the five cases examined.

We conclude from these results that there is no evidence that the cell bodies and their unsheathed axons suffer any significant loss of water between birth and maturity, and that the progressive diminution in the water content of the entire brain and spinal cord is mainly due to the accumulation of myelin—with a water content of about 50%. Moreover, the myelin must be regarded as a more or less extraneous substance, having but little significance for the characteristic activities of the neurons. As the diminution in the percentage of water in the central nervous system is preëminently a function of age, and as it appears to be due almost entirely to the formation of the myelin, it

follows that the myelin formation is also a function of age. A glance at the graphs in Chart 1, and at column (4) in Table 3, will show that the most active production of myelin, as indicated by the rapid loss in the percentage of water, occurs early, i.e., during the first twentieth of the life span in both the rat and man.

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DIFFERENTIAL MITOSES IN THE GERM-CELL CYCLE OF DINEUTES NIGRIOR

By R. W. Hegner and C. P. Russell
ZOÖLOGICAL LABORATORY, UNIVERSITY OF MICHIGAN
Received by the Academy, May 26, 1916

One of the most interesting and important periods in the germ-cell cycle of certain insects is that during which oögonia give rise to nurse cells and oöcytes. While such a period does not occur in certain insects, such as the paedogenetic fly, *Miastor*, in which the nurse cells are of mesodermal origin (Kahle, 1908; Hegner, 1914), perhaps in the majority of the members of this class, the growth of the egg is preceded by the formation of nurse cells from which the oöcyte derives most of its contents.

Many investigators have studied the origin and history of the cellular elements within the ovaries of insects, but in only one family, the Dytiscidae, have clearly defined visible differences been discovered between the nurse cells and the oöcytes at the time of their origin from the same mother cells. In the diving beetle, *Dytiscus marginalis*, Giardina (1901) discovered true differential mitoses which result in the derivation of one oöcyte and fifteen nurse cells from each ultimate oögonium. In this case there is a series of four mitoses during each of which one cell divides unequally; the larger daughter cell is characterized by the presence of an extra-nuclear 'chromatic ring' and leads to the formation of the oöcyte; the other gives rise only to nurse cells. Giardina supposes that this peculiar chromatic ring consists of part of the chromatin